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CURRENT SERIAL RECORDS

# INTERNAL SPROUTING OF POTATOES

## SOME CAUSES AND CONTROLS

## AN INTERIM REPORT

Agricultural Marketing Service
Market Quality Research Division
and Agricultural Research Service
Crops Research Division

UNITED STATES DEPARTMENT OF AGRICULTURE

## SUMMARY AND CONCLUSIONS

These tests indicate that a lower percentage of potatoes treated with isopropyl-N-(3-chlorophenyl) carbamate (CIPC) will have internal and external sprouts than similar untreated potatoes held under the same storage conditions. Storage at 50° F. combined with CIPC treatment almost completely prevented internal sprouting.

Tests began April 1961 using Maine Katahdins from 40° F. storage. CIPC as an aerosol or dip was applied to unsprouted (dormant) and sprouted potatoes.

Dip treatment completely controlled both internal and external sprouting. Aerosol treatments reduced sprouting, but did not control it completely. High aerosol concentrations were more effective in reducing sprouting than low concentrations, and a double treatment was more effective than a single treatment.

Generally, slightly more internal sprouting occurred in potatoes treated after sprouting had started than in potatoes treated while dormant.

Most internal sprouting occurred at 60° F. Somewhat less developed at 70° and very little at 50°.

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## ACKNOWLEDGMENTS

The Dynafog Jr. and Microsol Model 202 applicators, and the aerosol and emulsifiable grades of Sprout-nip, isopropyl-N-(3-chlorophenyl) carbamate (CIPC), used in these tests were furnished by Columbia-Southern Chemical Corporation.

E. James Koch, Agricultural Research Service, assisted with the statistical design.

# Internal Sprouting of Potatoes

## Some Causes and Controls

By H. W. Hruschka, P. C. Marth, and P. H. Heinze[1]

During the 1960-61 storage season serious internal sprouting of Irish potatoes was reported in several storage areas in the United States of America (fig. 1). These reports indicated that the problem was not limited to any particular variety or location, although there was more trouble in some areas than in others.[2]

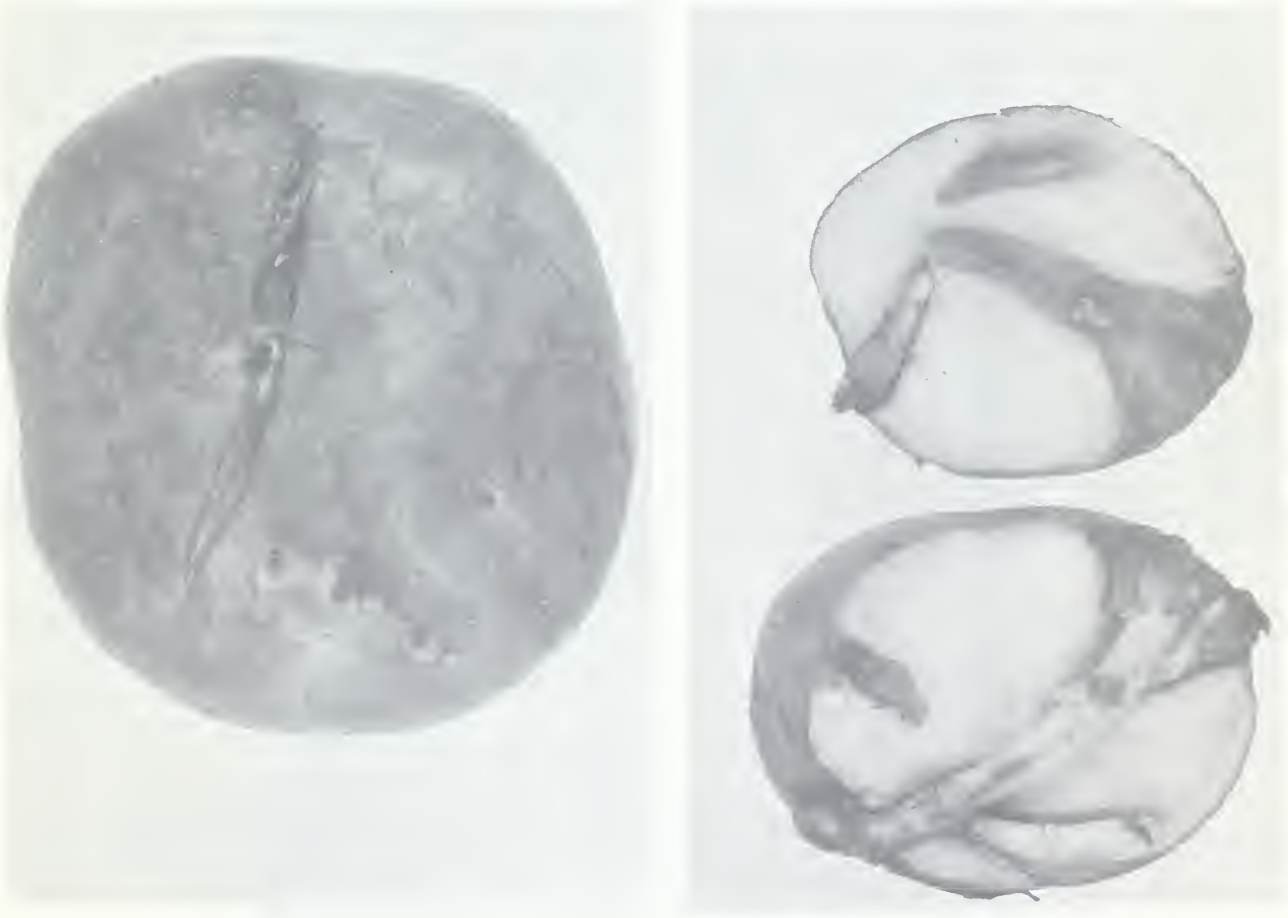

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Figure 1.--External and internal views of Katahdin potatoes from an Ohio storage. These potatoes with internal sprouting are fairly turgid.

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[1] H. W. Hruschka and P. H. Heinze are physiologists, Market Quality Research Division, Agricultural Marketing Service. P. C. Marth is a physiologist, Crops Research Division, Agricultural Research Service.

[2] Davis, R. M. Ingrown Sprouts in Potato Tubers: Factors Accompanying Their Origin in Ohio. Amer. Potato Jour. 38: 411-413. 1961.

Sawyer, R. L. Relation of Chloro IPC for Potato Sprout Inhibition to Internal Sprouting of Potatoes. Amer. Potato Jour. 38: 203-207. 1961.

Also, personal communications from potato storage operators.

In earlier years this difficulty was not encountered to any great extent during the usual storage season. Potatoes held very late or left as discards at the end of the season were occasionally found to have internal sprouts and internal tubers.

The tests reported here were designed to study the relation of the development of internal sprouting and internal tuberization to several factors, such as temperature in storage and concentration and time of application of a sprout inhibitor, isopropyl-N-(3-chlorophenyl) carbamate (CIPC). The purpose was to eliminate or reduce internal sprouting of potatoes during storage. These tests were part of a broad program of research to maintain quality and reduce costs by reducing waste in the marketing of farm products.

## MATERIALS AND PROCEDURE

Katahdin potatoes harvested in the fall of 1960 and held in storage in Aroostook County, Maine, at about 40° F. were shipped in 100-pound burlap bags in an insulated railroad car to Beltsville, Md., and unloaded on March 28, 1961. The potatoes were dormant on arrival, and no sprout inhibitor had been applied to them. The tubers were divided into seventy-two 25-pound samples, and each sample was placed into a 3-foot length of 10-inch diameter stovepipe fitted with a wire mesh floor about 8 inches from the basal end (fig. 2). The 72 samples were divided into 3 groups of 24 samples each and held at 40° F. until the start of the experiments.

Treatments were started on April 4, 1961. Eighteen samples from each of 2 groups of 24 samples in stovepipe storage containers were treated once before any sprouting started. Eighteen samples from one group were re-treated about 2 weeks later. The third group of 24 samples was allowed to produce sprouts about 3/4 inch long at 70° F. before 18 of them received treatment.

Each group of 24 samples was divided into 2 groups of 12 samples, which were subdivided into 4 lots of 3 samples each. One lot of three samples in each group of 12 received no sprout inhibitor and served as checks. The other three lots were treated with CIPC at three concentrations termed low, medium, and high levels. These concentrations were calculated to be about 1/3, 1 1/2 and 3 grams per hundredweight of potatoes; however, the conditions of application made these calculations very rough approximations.

Nine samples from one group of 12 samples in each 24 were treated with an aerosol of CIPC from an applicator that produces a smoke-type aerosol; nine samples from the other group of 12 were treated by using a type of applicator that produces a liquid mist type of aerosol. A commercial CIPC solution, aerosol grade, was used in both applicators. After treatment one sample from each lot of 3 samples was placed at 50°, 60°, and 70° F. for storage and later examination for internal sprouting. All storage rooms were maintained at a relative humidity of approximately 80 to 90 percent.

The experiment was therefore a 3x2x4x3 factorial design involving 3 treating times, dormant tubers with 1 application, dormant tubers with 2 applications, and sprouted tubers with 1 application; two methods of aerosol application, smoke-type applicator and liquid mist applicator; 4 concentrations of CIPC, zero, low, medium, and high; and 3 storage temperatures, 50°, 60°, and 70° F.

The CIPC was applied by filling a room 10 x 10 x 20 feet with a known amount of aerosol and drawing a calculated amount of this air-CIPC mixture through the pipes with a suction fan (fig. 2). The room was aired thoroughly between treatments. As a supplement to the 72 samples discussed previously, additional comparable samples, also held in stovepipes at 40° F. until treatment, were dipped in a 0.5 percent suspension of CIPC.

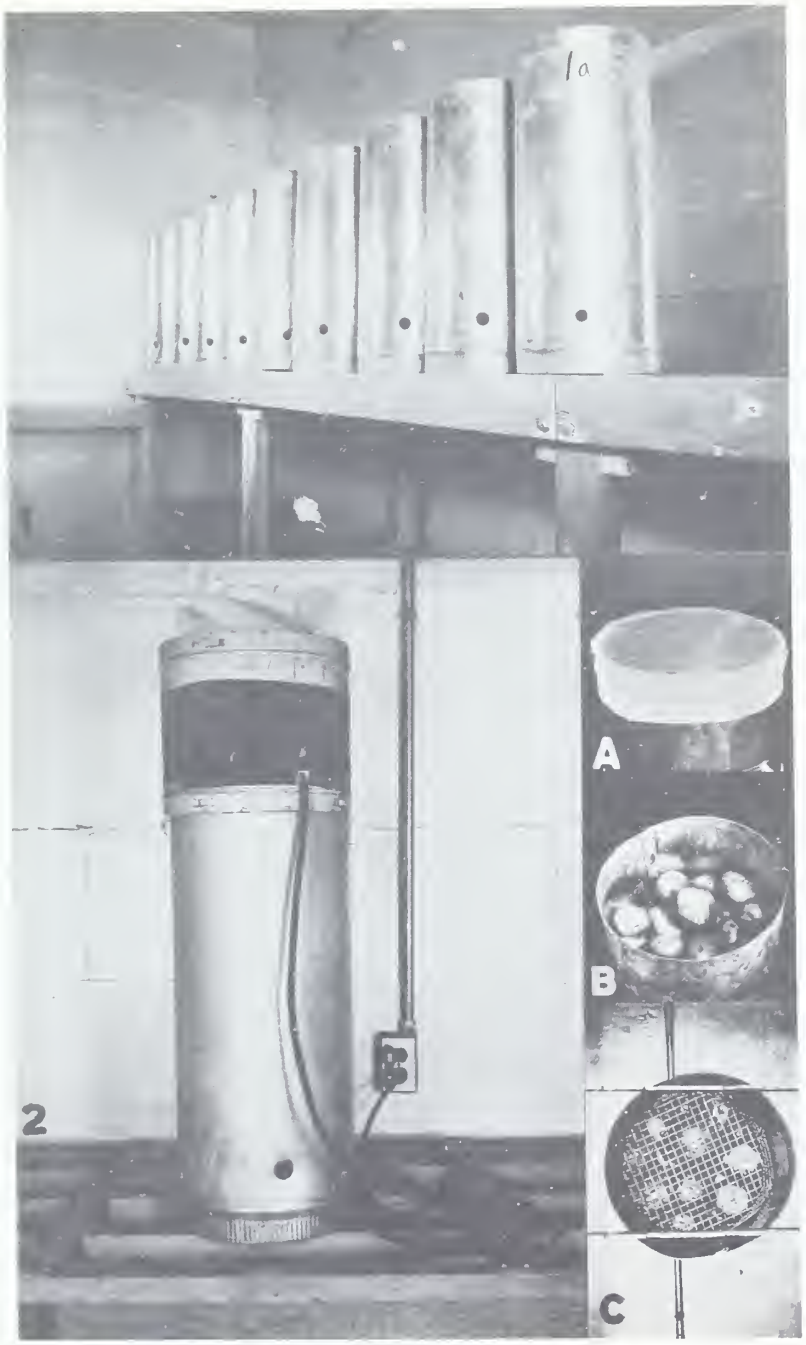


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Figure 2.--Potatoes placed for treatment and storage in 3-foot-long, 10-inch-diameter stovepipes fitted with wire mesh floor about 8 inches from the base. 1. Filled pipes in storage after treatment. 2. Single pipe and fan assembly during treatment. Air containing isopropyl-N-(3-chlorophenyl) carbamate (CIPC) aerosol moves past potatoes by suction created by fan. A. Top view of fan with plastic cover settled into place after treatment. B. Top view of pipe showing potatoes. C. Bottom view of pipe showing wire mesh and potatoes.

The potatoes were examined for internal sprouting the week of September 4, after about 5 months' storage. Fifty tubers (25 from the top section and 25 from the bottom section of the container) of each sample were cut and critically examined, especially near each eye, to determine the degree of internal sprouting. Considerable internal tuberization occurred in many of these potatoes. In the presentation of the data the term "internal sprouting" includes internal tuberization. Figures 3, 4, and 5 illustrate various types of internal sprouting found in these experiments.

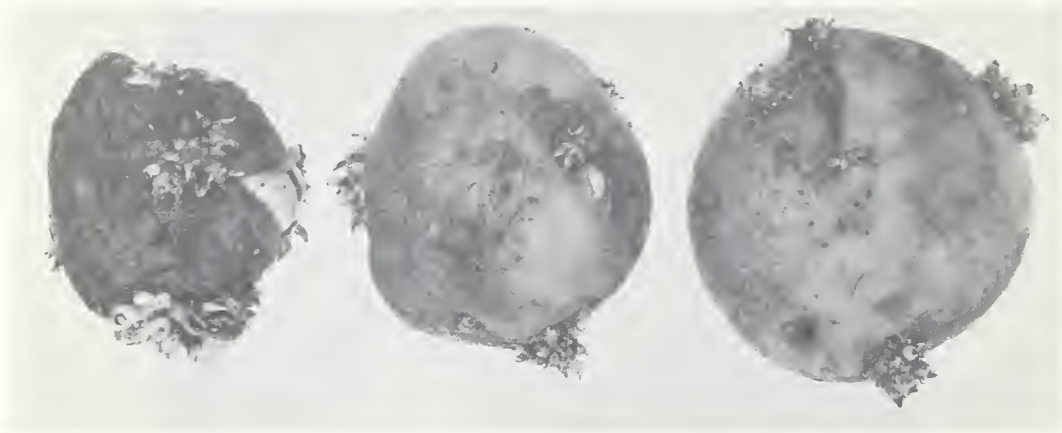

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Figure 3.--Internally sprouted Katahdin potatoes.

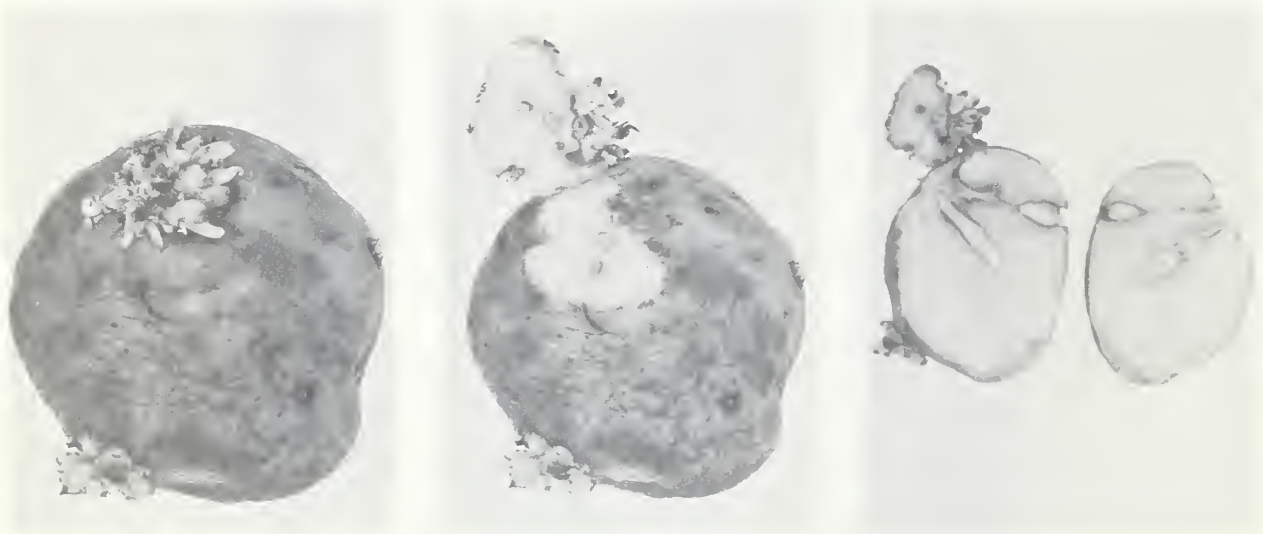

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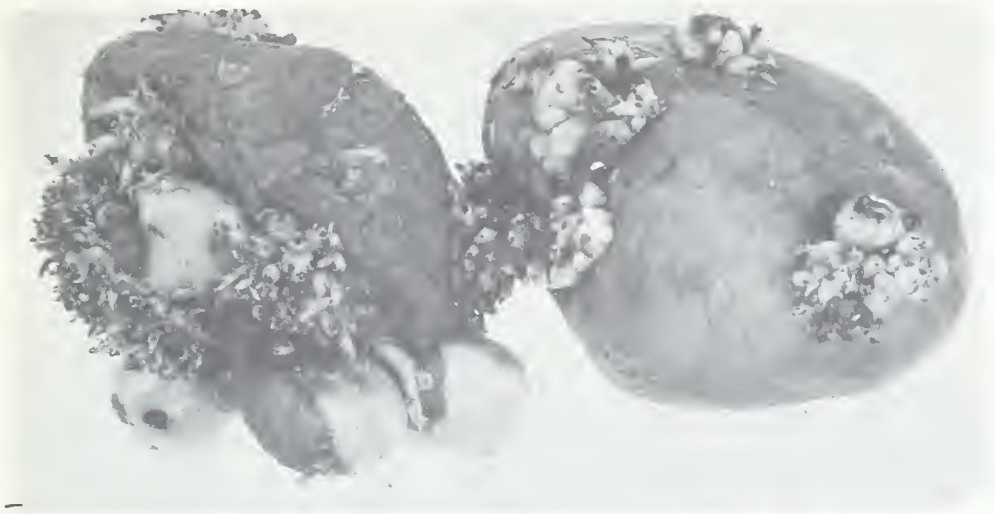
Figure 4.--Internally sprouted potato viewed externally and internally (tangential and cross section); cutting beneath the eye revealed the internal sprouts. Untreated and treated potatoes had similar symptoms.

The potatoes were in storage at about 40° F. for 6 months before the start of these tests. Commercial potatoes for processing are usually stored at higher temperatures throughout the storage period.



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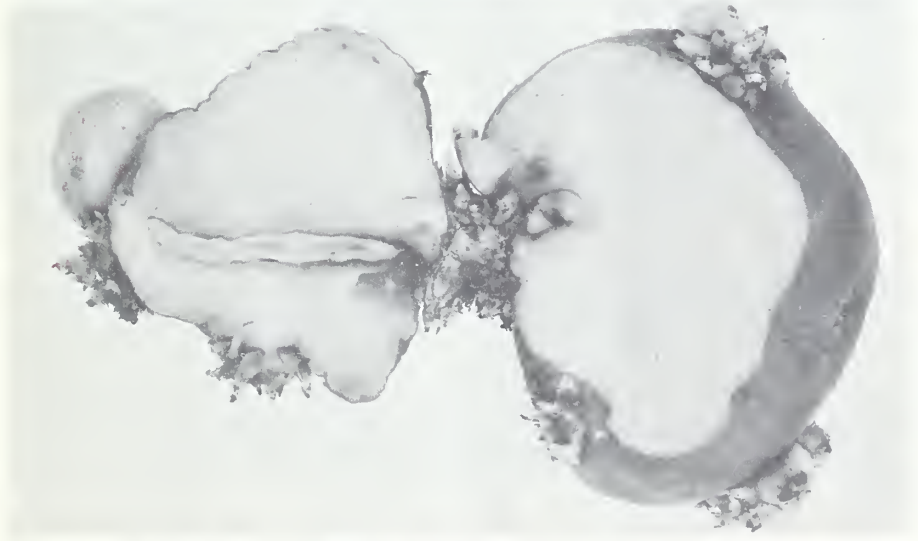

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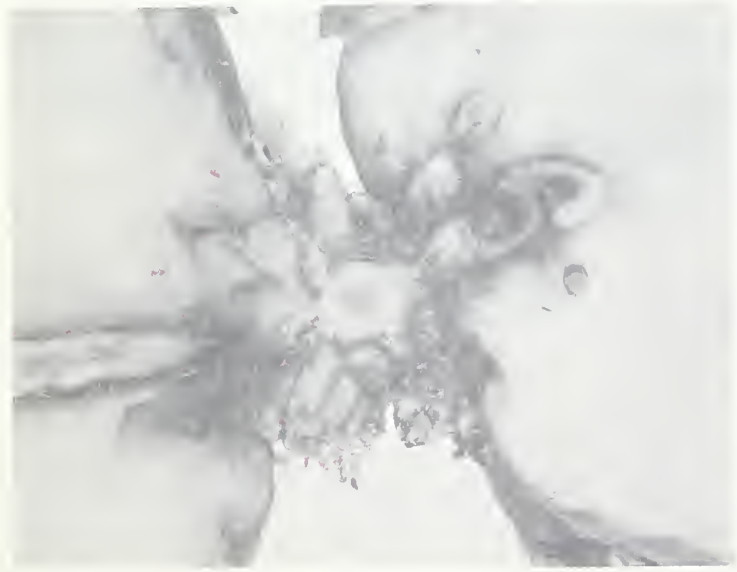

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Figure 5.--Most internal sprouts grew back into mother tuber. Potato on left (in all three views) sprouted into itself and also into the adjacent tuber.

## RESULTS AND DISCUSSION

### Temperature

Internal sprouting was found in more potatoes stored at 60° F. than at either 70° or 50°, as shown in the following tabulation. This tabulation is based on all the potatoes stored at each temperature except those dip-treated.

| Storage temperature | Potatoes with internal sprouting[1] |
|---|---|
| | Percent |
| 50° F. | 1.5 c |
| 60° F. | 14.4 a |
| 70° F. | 9.8 b |

[1] Letters after the percent indicate Duncan Multiple Range Test groupings at 5% level. Averages followed by no letters in common are significantly different.

Considerably more potatoes sprouted internally at 70° than at 50°. These data indicate that storage at about 50°, instead of at higher temperatures, would lessen the dangers from internal sprouting to a great extent. In the past internal sprouting has been associated with old potatoes. Higher storage temperatures increase the rate of aging and may affect the development of internal sprouting because of the physiological age of the tubers.

Late-crop potatoes of satisfactory quality for chip-making at harvest can usually be maintained in a satisfactory condition for chipping if stored at temperatures of 50° to 55° F.[3] In the tests reported here there was nearly 10 times as much internal sprouting in the potatoes held at 60° as in those held at 50°. External sprout growth increases rather rapidly as the temperatures are raised from about 40° to 60°.[4] Above 60° the rate of increase slows down considerably until no further increase in rate is noted between 75° and 80°. In contrast, these tests indicate that the development of internal sprouts is greatest somewhere near 60°.

The severity of sprouting of untreated potatoes stored at 50° F. and 70° is illustrated in figure 6.

[3] Wright, R. C., and Whiteman, T. M. A Progress Report on the Chipping Quality of 33 Potato Varieties. Amer. Potato Jour. 26: 117-120. 1949.
Wright, R. C., and Whiteman, T. M. Chipping Quality of Eight Potato Varieties as Affected by Source and by Storage Treatment. U. S. Dept. Agr. Cir. 936, 12 pp. 1954.

[4] Burton, W. G. The Dormancy and Sprouting of Potatoes. Food Sci. Abs. 29: 1-12. 1957.

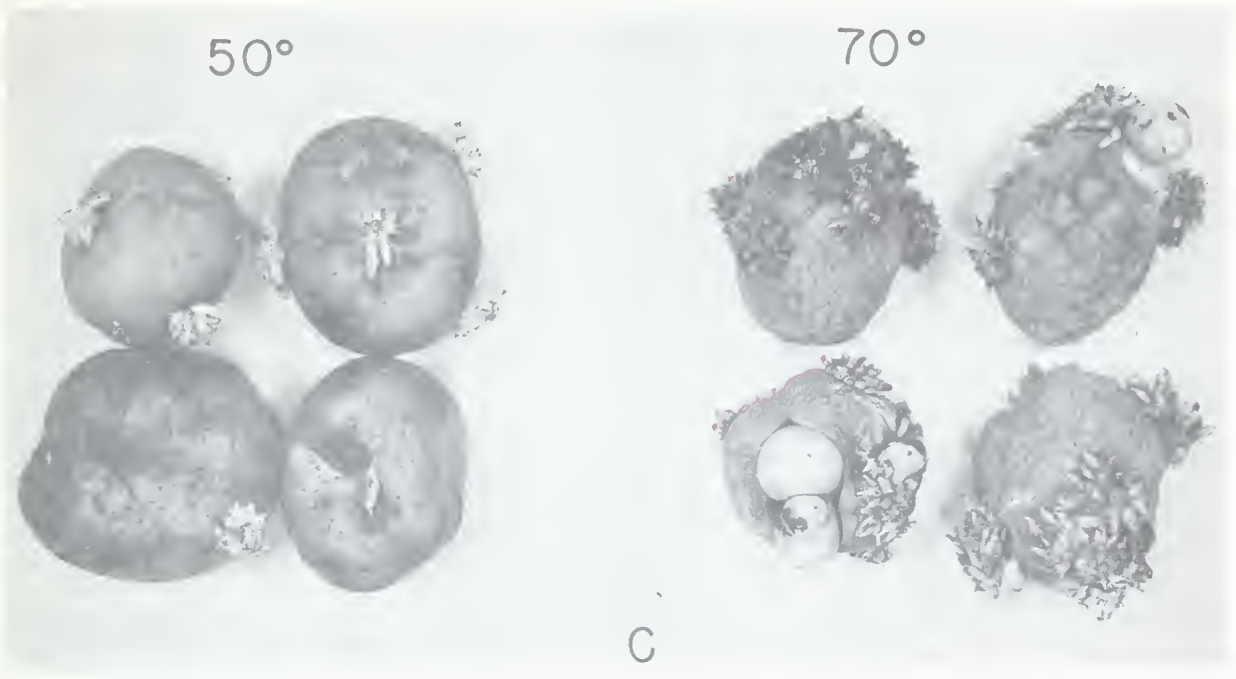


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Figure 6.--Sprouting of untreated potatoes at 50° and 70° F.

## Concentration of CIPC

More internal sprouting was found in the untreated (check) samples than in the potatoes treated with CIPC, as shown in the following tabulation. These figures are based on data obtained at all three temperatures.

| CIPC concentration | Potatoes with internal sprouting[1] |
|---|---|
| | Percent |
| None (checks) | 12.0 a |
| Aerosol, low | 9.2 ab |
| Aerosol, medium | 7.6 bc |
| Aerosol, high | 5.6 c |
| Dip, 0.5% suspension | 0 d |

[1] Letters indicate Duncan Multiple Range Test groupings at 5% level. Averages followed by no letters in common are significantly different. Averages followed by same letter are not significantly different.

Generally, the samples treated with higher concentrations of CIPC had fewer internally sprouted potatoes than samples treated with lower concentrations. Potatoes dipped in a 0.5 percent suspension of CIPC developed no internal or external sprouts at any storage temperature.

Severity of internal sprouting was related to degree of external sprouting. The samples receiving the higher concentrations of CIPC had less external sprout growth than those receiving low concentrations. Nearly all aerosol treated potatoes and all untreated potatoes had external sprouts. It seems therefore that the CIPC actually on the treated potatoes was considerably less than the calculated amount applied. Earlier work showed

that concentrations of CIPC as high as those calculated for high treatment levels in the presently reported tests should have completely inhibited external sprout growth.[5]

A second application of aerosol sprout inhibitor reduced the incidence of internal sprouting in most instances (table 1). The response to two applications was usually greater than the added effects of doubling concentration in a single application. All except one of the samples receiving two applications of aerosol and held at 60° or 70° F. had significantly less internal sprouting than the checks. In contrast, only two samples receiving single applications of aerosol had significantly less internal sprouting than the checks. These were the potatoes receiving the highest concentration of CIPC applied to both the dormant and sprouted tubers and stored at 60°.

All potatoes stored at 50° F. had little or no internal sprouting. Therefore, the differences between one and two applications or even between treated and untreated samples were not significant.

Table 1.--Internal sprouting in Katahdin potatoes treated with isopropyl-N-(3-chlorophenyl) carbamate (CIPC) aerosol or dip, once or twice and stored at 50°, 60°, or 70° F.

| Storage temperature, treatment method, and dose | Potatoes with internal sprouting[1] | | |
|---|---|---|---|
| | Treated before sprouting | | Treated once after sprouting |
| | Once | Twice | |
| | Percent | Percent | Percent |
| 50° F.: | | | |
| None (checks) | [2] 4 g-k | [2] 2 i-k | [2] 9 f-k |
| Aerosol, low | 0 k | 0 k | 2 i-k |
| Aerosol, medium | 0 k | 0 k | 1 jk |
| Aerosol, high | 0 k | 0 k | 0 k |
| Dip, 0.5% suspension | 0 k | -- | 0 k |
| 60° F.: | | | |
| None (checks) | [2] 23 a-c | [2] 16 b-f | [2] 20 a-e |
| Aerosol, low | 22 a-c | 2 i-k | 26 a |
| Aerosol, medium | 16 b-f | 1 jk | 23 ab |
| Aerosol, high | 11 e-l | 6 g-k | 7 f-k |
| Dip, 0.5% suspension | 0 k | -- | 0 k |
| 70° F.: | | | |
| None (checks) | [2] 12 d-h | [2] 13 c-g | [2] 9 f-k |
| Aerosol, low | 12 d-h | 3 h-k | 16 b-f |
| Aerosol, medium | 5 g-k | 1 jk | 21 a-d |
| Aerosol, high | 10 f-j | 10 f-j | 6 g-k |
| Dip, 0.5% suspension | 0 k | -- | 0 k |

[1] Letters following percent figures indicate Duncan Multiple Test Range groupings at 5% level. Figures with no letters in common are significantly different. Figures with same letter are not significantly different. Dash indicates that all intervening letters are included.

[2] Checks were not treated, but they were examined at the same time as the treated samples.

[5] Sawyer, R. L., and Dallyn, S. L. Vaporized Chemical Inhibitors and Irradiation, Two New Methods of Sprout Control for Tuber and Bulb Crops. Amer. Soc. Hort. Sci. Proc. 67: 514-521. 1956.

At 70° F. the responses to concentration levels of CIPC were erratic. However, the potatoes treated before sprouting showed a trend toward less internal sprouting as more CIPC was applied either by increased concentration or by two applications. The high concentration was an exception in the trend.

The type of aerosol treatment had no significant effect on internal sprouting.

## CIPC on Sprouted Tubers

Although all applications of CIPC in these tests were made later in the storage season than is usual commercially, the potatoes had been stored at 40° F., and none had sprouted at the beginning of these experiments. Potatoes that were allowed to produce sprouts at 70° before treatment with one application of low or medium concentrations of CIPC generally developed slightly more internal sprouting than those given one application while dormant (table 1). This trend was reversed, however, in potatoes receiving the high concentration of CIPC. The differences were not statistically significant. The sprouted samples receiving low and medium concentrations of aerosol and stored at 60° or 70° had slightly more internal sprouting than untreated samples, but only the potatoes treated with the medium concentrations of aerosol and stored at 70° had significantly more internal sprouting than untreated samples.

The sprouted tubers receiving the dip treatment did not develop internal sprouts at any of the three storage temperatures.